phere, which turned from northeast to southwest. From the 24th to 26th very hot, with threats of rain in the afternoon, and very dense smoke everywhere in the San Jose and Alajuela basins. From the 27th to the end of the month the northeast trade wind was again dominating from the surface of the country up to the highest strata of the atmosphere, as indicated by the clouds.

Notes on earthquakes.—March 11, 2h. 51m. 30s., a. m., heavy shock, west to east; intensity, 3; duration, 16 seconds. March, 12, 4h. 44m. p. m., slight shock, northeast to southwest, intensity, 2; duration, 2 seconds.

TABLE 3.—*Rainfall at stations in Costa Rica*, 1901.

Stations.	January.		February.		March.	
	Amount.	No. rainy days.	Amount.	No. rainy days.	Amount.	No. rainy days.
	Mm.		*Mm.*		*Mm.*	
1. Boca Banano	265	17	98	11	278	14
2. Limon	304	19	72	9	214	15
3. Swamp Mouth	.....	.....	131	10	241	13
4. Zent	.....	.....	.....	.....	.....	.....
5. Gute Hoffnung	411	15	106	14	224	12
6. Siquirres	406	10	45	4	160	8
7. Guapiles	340	18	114	8	... .	.....
8. Sarapiqui	.....	.....	.....	.....	.....	.....
9. San Carlos	301	19	67	14	96	13
10. Las Lomas	521	16	131	10	181	14
11. Peralta	335	11	65	4	190	13
12. Turrialba	.....	.....	.....	.....	.....	.....
13. Juan Vinas	159	14	40	10	12	6
14. Santiago	.....	.....	.....	.....	.....	.....
15. Paraiso	.....	.....	.....	.....	.....	.....
16 San Rafael C	.....	.....	.....	.....	.....	.....
17. Tres Rios	2	1	5	1	... 0	 0
18. La Palma	.....	.....	.....	.....	.....	.....
19. S. Francisco G	7	2	9	1	26	1
20. San Jose	4	2	9	1	24	1
21. La Verbena	.....	.....	5	2	6	2
22. Alajuela	 0	 0	1	1	.....	.....
23. Nuestro Amo	....	....	11	2	50	3
24. Sipurio	....	.....	.....	.....	149	12

DAMAGE BY HAIL IN SPITE OF CANNONADING.

By Prof. J. M. PERNTER.

[Translated from the Meteorologische Zeitschrift for March, 1901, page 135.]

In the January number of the Meteorologische Zeitschrift we stated with what exuberant certainty the great majority of the participants in the congress at Padua asserted the efficacy of the cannonading against hail. There were really no satisfactory proofs of this assertion and we stated the conditions that must be fulfilled by any acceptable demonstration of the fact. Practically, however, as the matter now stands it is greatly to be desired that we should know exactly what results have been obtained, and for this purpose we must not only be informed as to the successes, but also as to the failures. In spite of the very proper demand of Professor Poggi these latter never came up for close demonstration and discussion at the Padua congress; the members of the congress would not admit that there had been any failures. Nevertheless, it is necessary to know about them. Since in order to judge of the truth of the matter it is necessary for the meteorologist to be informed as to these details, we would call attention to the report for the last year's cannonading season, made by the inspector-general of the Italian Hail Insurance Company to the directors in Milan (Relazione dell' ispettore generale, Ingegnere Giuseppe Stabilini, sull' esito spari contro le nubi nel 1900 e nel congresso grandinifugo tenuto in Padova nel Novembre 1900). In this report Señor Stabilini cites 16 cases in which, so far as can be seen, he is actually in a position to show that in spite of all the severe and prolonged shooting some severe hail and some very severe damage from hail was done in the cannonading region itself. The accuracy of these facts is quite beyond doubt. It is so much the more to be regretted that the Weather Shooting Congress in Padua did not take advantage of the opportunity to investigate these cases more fully. For each case we should know: (1) the area of the region provided with cannonading apparatus; (2) its extent in latitude and longitude; (3) the distances of the cannon from each other; (4) the dimensions of the cannon; (5) the quantity of the charges of powder and the frequency of shots. If, further, the path of the storm and hail were given, then a discussion of the causes of failure in each case might profitably have taken place. On the authority of his report, Señor Stabilini concludes that the cannonading is almost useless. This is, however, too hasty a conclusion and not logically justified by the report. It is, however, very disquieting that in so many cases heavy and most severe damage should have been done in spite of the "best shooting."

I repeat again and again that it appears to me most probable that the smallness of the apparatus and the light charges have, through the facts brought forward by Señor Stabilini, now been proved to be insufficient; it does no good to shut our eyes to the facts.

Professor Pernter has elsewhere stated his desire that the heaviest charges of powder may be used, and the most thorough local investigation be made in order that the efficacy of cannonading be proved or disproved once for all. He considers the current delusion as an admirable chance to promote the study of thunderstorms and hail.—ED.

MONTHLY STATEMENT OF AVERAGE WEATHER CONDITIONS FOR MARCH.

By Prof. E. B. GARRIOTT.

The following statements are based on average weather conditions for March, as determined by long series of observations. As the weather of any given March does not conform strictly to the average conditions, the statements can not be considered as forecasts:

In March the storms of the middle latitudes of the North Atlantic Ocean are more numerous but less severe than during January and February. Fresh southerly winds prevail from the British Isles to the Grand Banks, and northwest winds from the Grand Banks to the United States coast. But little fog is encountered in the transatlantic steamship tracks. The southward movement of icebergs over the Banks of Newfoundland usually begins late in February or early in March. In the West Indies severe wind storms seldom occur during the dry season, which continues from November to April.

Although the wet season in the Pacific coast States of the United States continues from October to May, fully one-half of the annual rainfall occurs from December to February. In the Plateau regions the monthly rainfalls do not differ materially during the fall, winter, and spring months. Over the Great Plains which stretch from the Rocky Mountains to the Mississippi River, the monthly rainfall increases from February to June. East of the Mississippi the differences in the monthly rainfalls are not conspicuous, except that there is a general tendency toward a maximum in the summer months.

Although heavy snowstorms are practically unknown in the Southern States in March, and of infrequent occurrence in the northern districts, some very remarkable and memorable snowstorms have visited the northern districts of the United States in that month, principal among which may be placed the great storm of March, 1888, which proved so destructive to life and property in the Northeastern States. All of the severe March snowstorms of the Northeastern States have attended storms which have advanced from the southwest quarter.

The period of damaging frosts in the interior of the South Atlantic and Gulf States extends from November to April. Damaging frost is likely to occur in Florida from the middle of October until nearly the middle of April. Freezes of a character to injure oranges and orange trees in Florida, are, however, practically unknown in March.

NOTES BY THE EDITOR.

SNOW CRYSTALS.

On page 541 of the MONTHLY WEATHER REVIEW for December, 1900, we have referred to the extensive collection of snow crystals accumulated by Mr. W. A. Bentley, of Nashville, Vt., by the process of micro-photography. Mr. Bentley has kindly promised that the readers of the MONTHLY WEATHER REVIEW shall be favored with a very complete series of photographs and notes, and the Editor hopes by this publication to contribute to the foundation of our knowledge of the formation of clouds and rain. In Appleton's Popular Science Monthly for May, 1898, Mr. Bentley published a first account of some of his general deductions from the study of the snowflakes and the weather that is associated with them. By permission of the editor we reproduce some paragraphs from that work:

Careful examination of the illustrations will soon convince one that, great as is the charm of outline, the internal ornamentation of snow crystals is far more wonderful and varied. Many of the specimens, we might almost say all of them, exhibit in their interior most fascinating arrangements of loops, lines, dots, and other figures in endless variety. So far as is known to the writer, the illustrations are the first that have been published which show in any adequate manner these interior figures, and surely they add greatly to our interest and delight as we study snow crystals. So varied are these figures that, although it is not difficult to find two or more crystals which are nearly, if not quite the same in outline, it is almost impossible to find two which correspond exactly in their interior figures.

It is asserted by some observers that many of the lines or rods seen in the interior of snow crystals are really tubes filled with air.

Perfect crystals are by no means always common in snowstorms, most of the forms produced being more or less unsymmetrical or otherwise imperfect. It rarely happens that during a single winter there are more than a dozen good opportunities for securing complete crystals, and there may not be half so many. The greater number of perfect crystals is found in widespread storms or blizzards, while the local storms produce most often granular or imperfect forms. So marked is this distinction that very often the character and extent of a storm may be in general determined by an examination of the crystalline forms obtained. Extensive storms produce smaller crystals, more uniform in size, less clustered in flakes, and in greater variety than local storms. When the temperature is very low while a local storm is raging, its crystals resemble those of the blizzard more closely.

Some forms are common to both classes of storms. Probably because identical conditions do not occur frequently, the crystalline forms of each storm during a winter may differ from each other, one type appearing abundantly in one storm, a different type in the next, and so on. Conversely, the types most common in a given storm may reappear after an interval of months or years.

Not only do different storms afford different types of crystals, but different parts of the same storm, if it be general, give different forms. In this region the northern and western portions of the storm area produce more perfect crystals than the southern and eastern, and from this we infer a difference in the atmospheric conditions in these portions, the former being more quiet and otherwise favorable to crystallization.

In what has been called granular snow we find only loose, irregular subcrystalline forms, which are larger and heavier than others. This is formed in the middle or lower cloud layers, and when these are disturbed by wind or otherwise rendered unsuitable for crystallization. Sometimes, perhaps always, these granular masses have nuclei of true crystals. Granular snow may explain the origin of the great raindrops which often fall during a thundershower. It is probable that such drops have a snow origin. Most, if not all, hailstones also originate in granular snow, as their thin, opaque centers and concentric rings of opaque, snowlike ice show.

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It is unfortunate that the depth and solidity seen in some crystals, when the photographs are mounted as stereoscopic views, can not be in some adequate manner reproduced in engravings, for this adds not a little to an understanding of the manner in which the crystals have been formed. * * * A careful study of this internal structure not only reveals new and far greater elegance of form than the simple outlines exhibit, but by means of these wonderfully delicate and exquisite figures much may be learned of the history of each crystal, and the changes through which it has passed in its journey through cloudland. Was ever life history written in more dainty hieroglyphics? It is well known that crystals which form in a low temperature are smaller and more compact than those formed in a warmer atmosphere. As the higher cloud strata are colder than those nearer the earth, the snow crystals which originate there are smaller and less branched than those from lower clouds. * * * The small compact crystals of the upper clouds do not always remain of their original form and size, for, as they fall through layer after layer of clouds, each layer subjecting them to its own special conditions, they may be greatly modified, and by the time they reach the earth they may closely resemble the crystals from lower clouds, though they can usually be distinguished from them by an examination of the internal structure, as well as by, in some cases, their general form. All crystals falling from high cloud strata, the cirrus or cirro-stratus, are not changed; especially is this true in a great storm, or when the temperature of the lower clouds is low, and in any case some are much more completely transformed than others. One crystal may pass through cloud layers not very unlike that from which it came, and of course will not be greatly changed. Another may encounter here a quiet cloud layer and there a tumultuous layer; here a lower, there a higher temperature; here a dense and there a thin cloud mass; and by all of these conditions may be affected. * * * Total transformation, such as the change from one type into another, does not often occur. The nucleus retains its original form, to which various additions are made during the downward passage. Composite crystals may, however, be formed during the passage through diverse cloud layers, though they are not common. Usually, however, the tabular, compact, small crystals of the high clouds continue their development at lower levels upon the original plan, though becoming larger and more complex by the addition of branches at the angles. The triangular forms are less common than the others figured, and occur usually in the greater storms. A very unique composite crystal, which beginning in the higher clouds as a simple hexagon, received the peculiar additions which are well shown in one of the figures. An exceedingly unusual figure is that of a composite crystal formed from two, each of which has been in some way broken apart, and the portions then so brought in contact as to unite and form a single crystal of very nearly the original form of each of its parts.

CHARTS OF ATMOSPHERE HUMIDITY.

At the last meeting of the British Association for the Advancement of Science Dr. E. G. Ravenstein read a paper on the geographical distribution of relative humidity, a summary of which was given in the annual report of the association for 1900, page 817, about as follows:

Dr. Ravenstein stated that the importance of relative humidity as a climatic factor was fully recognized. Having illustrated its influence upon organic life, upon agriculture and human industries, he expressed his regret that neither in number nor in trustworthiness did humidity observations meet the requirements of a person desirous of illustrating its distribution over the globe by means of a map. This was owing largely to defects in the instruments employed, incompetence of the observers, and unsuitability of the hours chosen for the observations. As to the humidity over the ocean, we were still dependent upon the observations made on board passing vessels, and he was afraid the time had not yet come when floating meteorological observatories would be stationed permanently throughout a whole year at a few well-chosen localities in mid ocean. Notwithstanding this paucity of available material, he had ventured, in 1894, to publish in Philip's Systematic Atlas a small chart of the world showing the distribution of humidity. The subject had not been lost sight of by him since then, and he now placed the results before this meeting. He did so with some diffidence, and over cautious meteorologists might condemn his action, but they must remember that when Berghaus, in 1838, acting upon suggestions made by Zimmermann and Humboldt, published the first isothermal chart, the observations on temperature were even less numerous than those on humidity were at present. His charts, of course, must be looked upon as sketches, but he felt confident that